Examples of nuclear security measures for nuclear facilities

Dimitar Dimitrov
Bulgarian Academy of Sciences - Institute of Metal Science Equipment and Technologies with Hydroaerodynamics Centre
"Acad. A Balevski", Sofia, Bulgaria
E-mail: ddimitrov@ims.bas.bg

Abstract: *The lifetime of a nuclear facility extends from the earliest planning stages through to its decommissioning. It is important to consider nuclear security early in the design of new facilities and during partial redesigns or modifications, as it can result in nuclear security for these facilities that is more efficient, more effective and better integrated with other safety, safeguards, operational and other measures. Nuclear security measures are also important during commissioning and operation, they should not cease at decommissioning, as they are important in addressing the protection of the remaining quantities of nuclear material or other radioactive material, which has accumulated during the operations stage.*

KEYWORDS: NUCLEAR AND RADIOACTIVE MATERIAL, NUCLEAR FACILITY, NUCLEAR SECURITY, NUCLEAR SECURITY MEASURES

1. Introduction

Nuclear facilities have often been designed without giving sufficient consideration to nuclear security until late in the design stage or after operational and safety features had already been determined. Nuclear security measures were added later, often resulting in the application of measures that were not integrated or fully compatible with measures relating to safety, safeguards, and operations.

Moreover, implementing new or additional security measures after a nuclear facility is in operation may be difficult and costly. Considering security requirements early in new designs, partial redesigns and modifications can result in nuclear security that is more efficient and effective as well as better integrated with other measures in the facility.

Various requirements apply to a nuclear facility during all stages in its lifetime, including nuclear safety, nuclear security, safeguards and operational requirements. As stated in [1], "Security measures and safety measures have to be designed and implemented in an integrated manner to develop synergy between these two areas and also in a way that security measures do not compromise safety and safety measures do not compromise security."

A balance should be achieved between these various requirements. Ideally, the measures implemented to meet these requirements should complement each other, but in some cases, the measures implemented may conflict with one another.

2. Eight stages in the lifetime of a nuclear facility

The lifetime of a nuclear facility is divided into the following eight stages: planning, siting, design, construction, commissioning, operation, cessation of operation and decommissioning.

2.1 The planning stage for a nuclear facility includes activities such as conceptual design and obtaining required approvals prior to receiving authorization to begin formal siting and design stages.

2.2 The siting stage for a nuclear facility generally comprises the consideration of candidate sites, taking into account various factors such as available infrastructure and workforce as well as geographical and security considerations. This would then be followed by a detailed evaluation of the candidate sites. The evaluation may culminate in a request for, and approval of, a selected site.

2.3 In some cases, the design stage is an iterative process - from conceptual design through to final design - that ultimately results in a request for approval to construct a nuclear facility. In other cases, generic designs may be developed and approved prior to the siting stage.

2.4 The construction stage comprises site preparation, the manufacture, acquisition and assembly of the components of the nuclear facility, the installation of components and equipment, and the performance of associated tests.

2.5 The commissioning stage comprises the process of making systems and components of facilities operational, along with initiating associated nuclear security activities, and verifying that the systems, components and activities are in accordance with the design and have fulfilled the required criteria.

2.6 The operation stage includes all routine and emergency operations of the facility once it is commissioned.

2.7 The cessation of operation stage describes a planned condition at a nuclear facility in which facility operations have ceased either permanently in preparation for decommissioning or for an extended period of time for major modifications, maintenance or repair.

2.8 The decommissioning stage includes the administrative and technical actions taken to remove the nuclear material and other assets from the facility.

Nuclear security measures can be removed from the facility when no nuclear material and other radioactive material remain and there is no longer the potential for unauthorized removal of nuclear material or an act of sabotage that causes unacceptable radiological consequences.

Although not explicitly defined as a stage, there are periods during the lifetime of a nuclear facility when it could be undergoing some type of modification during one of the stages. This typically occurs during the operation stage but may occur in other stages as well. These modifications could lead to a need for increased or altered nuclear security measures.

One such example is if the operator of a site with one nuclear power plant were to receive approval to construct a second power plant on the same site while continuing operation of the original three.

During construction, part of the site would be in the design stage through to the commissioning stage, while the other three would remain in the operation stage. Ultimately, when the new plant enters operation, the facility would enter a stage in which all four power plants were in the operation stage.

A second example is if, during the operation stage of a nuclear facility, modifications affecting physical protection measures were to be completed, such as changing a security boundary, addition of new target locations, removal of a target location, or installation of a new perimeter intrusion detection system. While the facility remained in the operation stage, the modifications to the physical protection equipment may be designed, constructed, tested and implemented.

3. Security measures during each stage

Below, the major nuclear security actions for each stage of the lifetime of a nuclear facility for the country, the competent authority and the operator are set out. These actions apply to new facilities as well as existing ones, although existing facilities may already have completed some of these actions.

In addition, some actions assigned in this section to the country could be delegated to the competent authorities, as appropriate. All aspects of nuclear security, including information security and computer security [2, 3], should be maintained during all relevant stages in the lifetime of a nuclear facility.

STAGE 1: Planning stage goals

Measures to address applicable regulatory nuclear security requirements for the new nuclear facility should be identified during the planning stage.

Major decisions will be made during this stage, and the importance of nuclear security should be recognized and reflected in these decisions.

Nuclear security goals at this stage:

(a) Ensuring that the nuclear security requirements are met that are set out in the legal and regulatory framework, as applicable to the proposed facility and the type and quantity of nuclear material and other radioactive material expected to be in use or storage at the facility;

(b) Ensuring the integration of nuclear security requirements with operational goals and safety requirements in the facility design specifications;

(c) Identifying nuclear security roles and responsibilities and assigning them to the various competent authorities and organizations involved in nuclear security at the facility;

(d) Establishing a framework for communication among all relevant stakeholder organizations (e.g. those responsible for nuclear safety, nuclear security, safeguards and facility operations);

(e) Identifying and developing nuclear security competencies (e.g. human resources and technical capabilities) needed to implement nuclear security measures;

(f) Raising awareness of security issues among all relevant stakeholder organizations.

STAGE 2: Siting stage goals

The location of the nuclear facility is identified during the siting stage. The siting of a nuclear facility has the potential to increase or decrease its vulnerability to external security threats as well as to increase or decrease the potential consequences that could result from malicious acts.

During site selection, nuclear security considerations should be evaluated alongside safety and other considerations, such as seismic activity, geology, meteorology and hydrology.

Nuclear security goals at this stage:

(a) Any local or regional threats that could impact the facility;

(b) Security interfaces and interdependencies with existing nearby nuclear facilities;

(c) Topography that may enhance or increase the vulnerability of the security of site;

(d) Potential impact of radiological releases to the environment or populated areas (e.g. population centres, critical infrastructure, airports and other transport assets, and international borders);

(e) The availability of sufficient response forces to respond in a timely manner to a nuclear security event;

(f) Free space for site reconfiguration, including expansion, if security needs increase.

STAGE 3: Design stage goals

Measures required to meet applicable regulatory nuclear security requirements should be integrated into the overall design during the design stage. Potential conflicts between safety and security measures should be identified and minimized during the design stage, and measures should be implemented in a manner to strengthen synergy between these two areas where possible.

For example, access control measures for sensitive areas in the facility need to account for both safety and security considerations.

Nuclear security goals at this stage:

(a) Developing nuclear security designs that meet regulatory requirements for nuclear security and accounting for the national design basis threat or representative threat statement as well as the preliminary facility analyses;

(b) Characterizing and evaluating the nuclear facility to determine the required protection levels for the facility for the protection of nuclear material and the possible radiological consequences of sabotage;

(c) Planning for nuclear security areas in the facility (e.g. limited access area, protected area, inner area and vital area) in order to provide defence in depth;

(d) Identifying locations and types of critical nuclear security asset, such as the central alarm station and guard stations;

(e) Identifying and resolving conflicts between regulatory requirements for nuclear security and those for other disciplines as early in the design stage as practicable.

STAGE 4: Construction stage goals

During the construction stage of a nuclear facility, the operator should take measures to ensure that the facility nuclear security measures are implemented as designed during the various stages of construction.

At or near the end of construction, nuclear security measures should be tested to determine that they are installed and operate in a manner that addresses the applicable regulatory requirements and the design basis threat or representative threat statement.

Nuclear security goals at this stage:

(a) Ensuring that the construction and installation of nuclear security measures meet design requirements;

(b) Preventing the introduction of contraband to the construction site as well as any tampering with facilities or equipment that could aid in the execution of a malicious act after the facility becomes operational;

(c) Isolating construction activities from other operational facilities (e.g. those located on the same site) and addressing interim security vulnerabilities which may be introduced to nearby facilities during the construction stage;

(d) Conducting preparatory activities, such as establishing an organization or organizations that will be responsible for nuclear security at the facility during and after construction, training security personnel and developing plans and procedures for nuclear security at the facility;

(e) Conducting testing of physical protection equipment and other systems and components that contribute to nuclear security following installation to ensure that they meet functional, operational and performance requirements.

STAGE 5: Commissioning stage goals

During the commissioning stage, the operator should demonstrate that the facility as constructed meets the design specifications,

including that the combination of nuclear security measures in place meets the applicable regulatory requirements.

This stage also includes administrative and technical actions taken to introduce the nuclear material into the facility. [4]

Nuclear security goals at this stage:

(a) Validating that the facility's nuclear security plans, operating procedures, assessment procedures, contingency and emergency procedures adequately address applicable regulations, the design basis threat or representative threat statement;

(b) Verifying that all physical protection equipment and other systems and components that contribute to nuclear security functions are in place and meet the design requirements;

(c) Implementing compensatory nuclear security measures to provide protection for the material until the nuclear security measures are fully operational if nuclear security measures are not fully implemented upon arrival of the nuclear material into the nuclear facility;

(d) Familiarizing all facility personnel with nuclear security processes and procedures;

(e) Developing a commissioning protocol to provide evidence that the nuclear facility, as constructed, meets the design specifications and complies with applicable regulatory requirements for nuclear security;

(f) Describing and evaluating the nuclear security measures described in the nuclear security plan through assessments, including performance testing;

(g) Establishing a formal process to evaluate the impacts on nuclear security from proposed operational changes, changes in nuclear safety measures or facility modifications prior to their implementation;

(h) Establishing a formal process to evaluate the impacts on facility operations and on nuclear safety from proposed changes to nuclear security measures prior to their implementation;

(i) Identifying and correcting deficiencies in nuclear security processes and procedures.

STAGE 6: Operation stage goals

During the operation stage, sustained, effective nuclear security should be maintained. The elements of nuclear security are described in a nuclear security plan, the development of which was mentioned in the previous two stages. [5]

The nuclear security plan should form the basis for oversight by the competent authority and is part of the license or authorization of the facility. Any major modifications to the facility's nuclear security measures should be subject to review and approval by the competent authority.

Nuclear security goals at this stage:

(a) Ongoing evaluations of nuclear security measures through inspections and performance testing, including exercises;

(b) Maintaining a formal process to evaluate the impacts on nuclear security from proposed operational changes, changes in nuclear safety measures or facility modifications prior to their implementation;

(c) Maintaining a formal process to evaluate the impacts on facility operations and on nuclear safety from proposed changes to nuclear security measures prior to their implementation;

(d) Ensuring that any compensatory measures are implemented to address non-compliance with requirements or failure of nuclear security measures;

(e) Maintaining a strong nuclear security culture;

(f) Responding to changes in the threat environment, as appropriate, through changes to the nuclear security system;

(g) Implementing sustainability and quality assurance programmes.

STAGE 7: Cessation of operation stage goals

As long as a risk of unauthorized removal of nuclear material or of sabotage leading to unacceptable radiological consequences remains, nuclear security measures should continue to be implemented on the site, although they should be tailored to the changing nature of operations on the site.

This applies whether the facility has ceased operation permanently, in preparation for decommissioning, or for an extended period of time for major modifications, maintenance or repair.

Nuclear security goals at this stage:

(a) Modifying nuclear security measures in situations where nuclear material inventories are relocated, removed, increased or otherwise changed, as needed;

(b) Accounting for impacts on nuclear security of reduction or reassignment of personnel resources;

(c) Supporting cessation activities by bringing in new entities and personnel to the facility, including contractors, as appropriate;

(d) Evaluating possible changes to nuclear security measures to account for changes to the facility that may impact the potential for sabotage;

(e) Reconfiguring security areas following changes to the facility configuration to ensure that adequate nuclear security measures continue to be in place, as appropriate;

(f) Evaluating process operations equipment and structures to identify quantities of nuclear material or other radioactive material accumulated in hold-up during the operations stage.

STAGE 8: Decommissioning stage goals3

The decommissioning stage involves activities that will ultimately lead to the removal of all nuclear material and other radioactive material from the facility. However, as long as a risk of unauthorized removal of nuclear material or of sabotage leading to unacceptable radiological consequences remains, nuclear security measures should be maintained.

The application of these measures should be based on a graded approach, taking account of the category of nuclear material and its potential for sabotage leading to unacceptable radiological consequences.

Nuclear security goals at this stage:

(a) Re-evaluating nuclear security requirements as the inventory of nuclear material and the potential radiological consequences associated with sabotage change;

(b) Re-evaluating process operations equipment and structures to identify hold¬up quantities of nuclear material or other radioactive material accumulated in them during the operations stage;

(c) Balancing safety and security objectives during decommissioning, for example, it may be required to delay decommissioning for dose reduction purposes (safety) versus the immediate removal of nuclear material and/or sensitive information for security purposes;

(d) Reducing nuclear security measures during the period while nuclear material and contaminated equipment is being removed from the nuclear facility, while continuing to meet regulatory requirements based on a graded approach;

(e) Ensuring proper disposal of sensitive information and security related equipment;

(f) Managing changes in the workforce or organizations that impact nuclear security at the facility, such as workforce reductions;

(g) Encouraging personnel to remain vigilant with regard to security awareness and nuclear security culture during decommissioning.

5. Conclusion

There are well known risks associated with the use of nuclear material and nuclear facilities. From a nuclear security perspective the two primary risks are those associated with unauthorized removal of nuclear material, for potential use in a nuclear explosive device, and with sabotage of the material and/or facility resulting in Unacceptable Radiological Consequences (URC).

The management of these risks is the primary basis for nuclear security in relation to nuclear material and nuclear facilities. If a country has made the decision to accept nuclear material and nuclear facilities within its borders, it is also accepting the responsibility to protect those materials from unauthorized removal and the facilities and materials from sabotage resulting in a release of radionuclides.

The country's physical protection regime should be reviewed and updated regularly to reflect changes in the threat and advances made in physical protection approaches, systems, and technology, and also the introduction of new types of nuclear material and nuclear facilities.

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